Messina 1908-2008: understanding crust dynamics and subduction in Southern Italy

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S43C-1899
Thursday
Starting Time: 13:40
Hall D

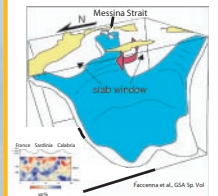
AGU FALL MEETING

Abstract

To mark the centennial anniversary of the 1908 earthquake that shook Messina, Italy, the Istituto Nazionale di Geofisica e Vulcanologia (INGV) has begun the "Messina 1908-2008" research project. The aim is to clarify the extension deformation processes that occurs in the Messina Strait and to understand the relationships between subduction and crustal deformation there by merging existing data and studies and by collecting new and more detailed seismological, geodetic, historical and satellite observations.

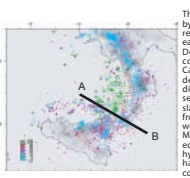
More than 20 permanent seismic stations and 16 temporary stations are located in the study region. A dense permanent geodetic network also operates in the region, several campaign surveys are newly available and new geodetic campaign measurements were performed in March 2008. In addition, during the summer of 2008, five ocean bottom seismometers (OBS) were deployed to better monitor the area largely covered by the sea. Records of historical earthquakes that struck the Strait of Messina will be analyzed and synthetic aperture radar images will help to define the surface deformation of the region. The Messina 1908-2008 project's assemblage of a database and integration of innovative technologies could transform our understanding of the crust and mantle structure of the active tectonics and seismic hazards of the Messina strait.

Southern Italy subduction system



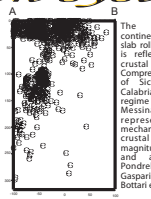
The evolution of this sector of the Eurasia-Africa plate boundary is generally interpreted in terms of slow northeast-southwest plate convergence, accompanied by relatively rapid rollback subduction. In its history, the subduction fragmented and formed arcs (i.e., the Calabrian Arc) limited by lateral windows. Researchers have considered various hypotheses about the role of the tears and how they influence the crust and mantle motion. The actual kinematics of the crust are difficult to reconcile with a traditional slab-rollback model, given the absence of geodetic evidence of backarc spreading in the Tyrrhenian Sea. However, magnetic anomalies indicate that spreading has been episodic [Nicolosi et al., 2006], with the present period being one of relative quiescence.

The inset left is a tomographic cross section showing the slab as a high-velocity perturbation dipping toward the northwest; white dots are earthquake hypocenters

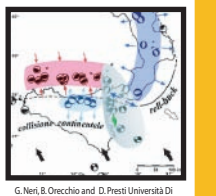


Courtesy of Claudio Chiarabba

The study area is characterized by a moderate seismic energy release, with few M > 5 earthquakes recorded each year. Deep seismicity is mainly concentrated offshore the Calabrian arc, down to 450 km depth, defining a 70° NW dipping Benioff plane. The seismically active portion of the slab is long, less than 250 km from southern Cilento to the western Eolian island. And the Messina strait is very close to its edge. The distributions of hypocenters at crustal depths have a sort of a gap in correspondence to the NE corner of Sicily



The coexistence of continental collision and slab roll-back in the region is reflected also in the crustal stress regimes. Compression is active north of Sicily, extension in Calabria. A transitional regime characterize the Messina Strait. The represented focal mechanisms belongs to crustal events with magnitude greater then 4 and are taken from Pondrelli et al. 2006, Gasparini et al. 1985 and Bottari et al. 1989.



G. Neri, B. Orecchio and D. Presti Università Di Messina, Dipartimento Di Scienze Della Terra

Geodetic measurements

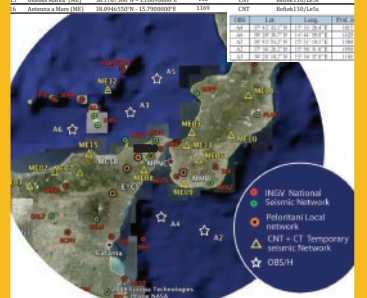
Valentina Bruno, Mimmo Palano an
Flavio Cannavò

March 2008 survey

Simplified tectonic map of north-eastern Sicily and southern Calabr ATL, Aeolian-Tindari-Letojan fault system; MS Messina Strait; PM, Peloritani Mts.; NM, Nebro Mts.. Inset shows detailed zoom c the dense Lipari Vulcano networ

On land and OBS Seismic deployment

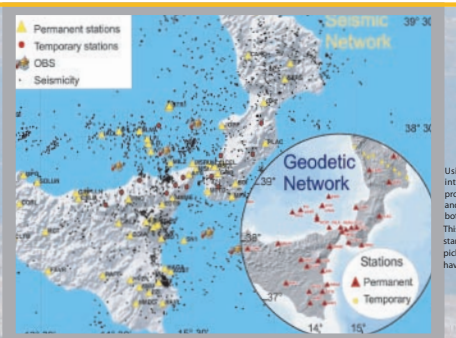
01*	Motticita (ME)	37.9318833°N – 14.3016180°E	945	CNT	Reftek130/La5a	2a
02*	San Pratello (ME)	38.0312150°N – 14.5900780°E	675	CNT	Reftek130/La5a	
03*	Palmi (MRC)	38.3218000°N – 15.8374190°E	945	CNT	Reftek130/La5a	2c
04	Bregantarro (VV)	38.5929150°N – 16.3537700°E	675	CNT	Reftek130/La5a	
05*	Diga Del Menta (RC)	38.1241222°N – 15.8998727°E	1432	CNT	Reftek130/La5a	2g / 2h
06	Antenna a Mare (ME)	38.1594800°N – 15.4647200°E	1130	CNT	Reftek130/La5a	
07	Castell'Umberto (ME)	38.0312083°N – 14.8192277°E	739	CNT	Reftek130/La5a	
08*	Mali (ME)	38.0530300°N – 15.4000000°E	1005	CNT	Reftek130/La5a	2d
09*	Pentidattilo (RC)	38.0054298°N – 15.4004500°E	992	CNT	Reftek130/La5a	
10*	Cittanova (RC)	38.3028733°N – 15.9353733°E	741	CNT	Reftek130/La5a	2f
11*	Novara di Sicilia (ME)	38.0270900°N – 15.1360000°E	750	CT	Taurus/La20a	
12*	Panarea (ME)	38.6350000°N – 15.0690000°E	120	CT	Taurus/La20a	
13	Scilla (RC)	38.2320000°N – 15.7900000°E	835	CT	Taurus/La20a	2g
14*	Gambarie(RC)	38.1620000°N – 15.7030000°E	500	CT	Taurus/La20a	2h
15	Gioiosa Marea (ME)	38.1707500°N – 15.0690000°E	336	CNT	Reftek130/La5a	
16	Antenna a Mare (ME)	38.0946550°N – 15.7900000°E	1169	CNT	Reftek130/La5a	



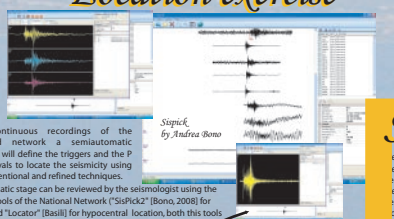
The OBS used in the deployment are produced by INGV Gibilmanna Observatory and had been tested only twice: the prototype was deployed in the Tyrrhenian sea near the Marsili spreading center and three OBS were deployed in the Ionian sea, for the NERIES project. The production of Italian OBS opens new frontiers to Italian seismologist and make possible an important marine development of the National Seismic Network. An appropriate ship was rented in the middle of July for few days to deploy the marine seismographs and the same was done to recover them at the beginning of November.

One of the OBS malfunctioned and came up after a few days from installation, thanks to a GPS disposal the OBS A3 was tracked, recovered and reinstalled.

OBS are equipped with a Trillium 120 s. sensor, an hydrophone (DPG band pass 160 s -2Hz), power supply, double recovery system and acquisition system on a 24 GB compact flash. An ad hoc leveling base was designed to improve leveling of the 120s Trillium sensor whose battery consumption strongly increases with tilt (>0.1°). Unfortunately the leveling worked fine only at one site (A3).



Location exercise



Using continuous recordings of the integrated network a semiautomatic procedure will define the triggers and the P and S arrivals to locate the seismicity using both conventional and refined techniques.

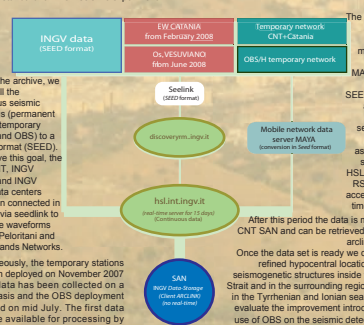
This automatic stage can be reviewed by the seismologist using the standard tools of the National Network ("SisPick2" [Bono, 2008] for picking and "Locator" [Basili] for hypocentral location, both this tools have been tailored for this task)

Locations, for 8 sample events recorded in August 2008, done using the Seismic National Network in green and in red the locations done using the land-sea integrated Messina 1908-2008 network. Formal errors in the locations decrease.

The deployment of the temporary stations and OBS almost double the number of stations that can be used to locate events.

Seismic data archive

One of the goals of the project is the creation of a waveform archive that will collect, in a uniform format, recordings of all the available seismic stations present in the region. It will be the first example of complete integration of data provided by permanent networks (INGV National Seismic Network; Peloritani Local network), temporary deployments (both mobile network from INGV CNT and INGV CT) and OBS data, that hopefully will become a standard for INGV seismic experiment



To build the archive, we convert all the continuous seismic recordings (permanent stations, temporary stations and OBS) to a uniform format (SEED). To achieve this goal, the INGV CNT, INGV Catania and INGV Napoli data centers have been connected in real time via seedlink to gather the waveforms from the Peloritani and Eolian Islands Networks.

Simultaneously, the temporary stations have been deployed on November 2007 and the data has been collected on a regular basis and the OBS deployment is planned on mid July. The first data should be available for processing by the end of November 2008.

The data is stored in the original format on the mobile network data server MAYA, then it is converted to SEED data format and fed to the HSL seedlink/arclink server. The assembled data set is stored in HSL together with RSN data and is accessible in real-time for 15 days.

After this period the data is moved to the CNT SAN and can be retrieved through the arclink interface.

Once the data set is ready we can compute refined hypocentral locations to define seismogenetic structures inside the Messina Strait and in the surrounding region especially in the Tyrrhenian and Ionian sea and we can evaluate the improvement introduced by the use of OBS on the seismic detection and on the earthquake location.

SAR Interferometry

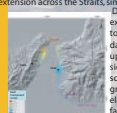
Stefano Salvi, Cristian
Tolomei, Simone Atzo

e used the SBAS SAR Interferometry technique to easure the ground velocities in the Messina Straits in the riod 1992-2001.

e calculated and inverted 67 ascending and 129 scending ERS interferograms, obtaining Line of Sight oS) velocity maps with estimated accuracy of 1 mm/yr.

e calculated from the LoS maps the Up and East mponents of ground velocity. To carry out this lculation we estimated, using Continuous and Survey- ode GPS data, that the variability of the North mponent across the Straits is about 1 mm/yr.

Figures 1 and 2 show the East and Up components of velocity, respectively; values are referred to the CGPS site TORC, in Reggio Calabria. We assume uncertainties of 1 mm/yr for the Up component and 1.5-2 mm/yr for the East component, based on previous applications of the SBAS technique. The East velocity field shows about 3 mm/yr extension across the Straits, similar to that estimated from GPS at a regional scale.



Data from GPS stations nearest to the coast yield a lower extension rate, Our results suggest that this may be due to local, non-tectonic signals affecting part of the GPS data. The Up velocities indicate that the Sicilian side is uplifting about 2.5 mm/yr with respect to the Calabrian side. Finally, we verified using non-linear inversion schemes, that such large interseismic deformation gradients cannot be simulated by simple, half space elastic dislocation models considering the known active faults of the area.

Messina 1908-2008 Team Members

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